Using a computer-based intervention to foster communication skills in children and adolescents with Asperger’s syndrome

by

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Abstract

An important part of written communication involves thinking about one’s reader’s mind, yet students with Asperger’s syndrome (AS) have difficulty representing the minds of others. The present study investigated whether providing visual feedback to AS students would help them learn to consider their readers’ knowledge state in their emergent compositions. Using a computer-based intervention, thirteen AS children constructed unconventional figures and then dictated instructions so that a confederate in another room could reproduce the images based on their instructions. Children assigned to an experimental condition received visual feedback; however, children assigned to a control condition did not. Compared to the control group, experimental participants significantly improved the descriptiveness of their instructions and could apply their newfound skills to a novel context approximately 6.7 weeks post-intervention. This intervention effectively improved the students’ communication skills and could serve as a practical educational tool to advance social and literacy skills in AS children.
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Introduction

Asperger’s syndrome (AS) is a pervasive developmental disorder characterized by autistic symptomology. Integral to the diagnosis of AS is social dysfunction, preoccupation with isolated and idiosyncratic interests, and rigid adherence to nonfunctional routines (Beaumont & Sofronoff, 2008). While AS shows qualitative similarities to disorders on the autism spectrum, individuals with AS do not exhibit clinically significant cognitive or linguistic delays and, in some cases, demonstrate above average intelligence and/or giftedness (Attwood, 2007). There has been a longstanding debate regarding the validity of Asperger’s as a distinct diagnostic entity from high functioning autism and whether or not AS should be withdrawn from diagnostic manuals, such as the forthcoming DSM-V. Though differences between the core features of high functioning autism and AS have been empirically documented (Ghaziuddin, 2010), there is still no conclusive evidence suggesting that both disorders are qualitatively distinct (Kaland, Callesen, Møller-Nielsen, Mortensen, & Smith, 2008).

A Cognitive Hypothesis of Autism Spectrum Disorders (ASD)

Over the past two decades, several theories have attempted to elucidate the neuropsychological underpinnings of ASD; however, one of the most influential views suggests that impairments in higher-order thinking, particularly in the domain of theory of mind, underlie the spectrum of disorders (Beaumont & Sofronoff, 2008). Attributing mental states, such as beliefs, emotions, intentions, and desires, to oneself or others is a metarepresentational act referred to as theory of mind (Leslie, 1987). This ability allows an individual to formulate judgments and predictions about the behaviours of others that are often based upon and influenced by their subjective cognitive states (Howlin, 2008).
Consideration for another person’s mind has been shown to develop during the late preschool years and marks a milestone in cognitive, linguistic, and social development (Holliway, 2004). There is robust evidence indicating that by four or five years of age typically developing children possess a functional theory of mind (Wellman, Cross & Watson, 2001).

**Theory of Mind and ASD**

Unlike their neurotypical peers, ASD populations exhibit difficulties in perspective-taking and show limited awareness of mental events. Baron-Cohen, Leslie, and Frith (1985) were among the first group of researchers to highlight the shortcomings of theory of mind in children with ASD. In their pioneering study, participants were presented with the “Sally-Ann” paradigm; a now widely-used marker of theory of mind competence that requires an individual to ascribe a false belief to another person (Wimmer & Perner, 1983). In this task, individuals witness a sequence of events between two dolls, Sally and Ann, that ends with Ann moving Sally’s ball from its original location to a new location in her absence. When children were prompted to answer the target question, ‘Where will Sally look for her ball?’, Baron-Cohen, Leslie, and Frith (1985) found that 80% of their ASD sample failed to provide the correct response. Instead of shifting their perspective to Sally’s knowledge state, children answered according to their own knowledge state, based on where they observed Ann move the ball when Sally left the room. However, to correctly answer the question and presumably demonstrate awareness of another’s mental events, a child must understand that the ball’s actual location was incongruous with Sally’s belief of the ball’s location, since she was not present when it was moved by Ann. The inability to ascribe this false belief to Sally
was shown to be specific to ASD children, since age- and language-matched peers of typical development and children with Down’s syndrome could understand that a person may hold a false belief when their mental states contradict reality (Baron-Cohen, Leslie, & Frith, 1985).

Despite Baron-Cohen, Leslie, and Frith’s (1985) compelling empirical support for a theory of mind deficit in ASD, a minority of participants (i.e., 20%) still passed the test of false belief, suggesting that mentalizing difficulties may not be universal among children with ASD. Subsequent studies validated this assertion and demonstrated that populations on the spectrum, especially those with a diagnosis of higher functioning autism or AS, were capable of succeeding on first-order (Dahlgren & Trillingsgaard, 1996; Eisenmajer & Prior, 1991) and even second-order (Bowler, 1992; Ozonoff, Rogers, & Pennington, 1991) false belief tasks, which assess an individual’s ability to reason about what one person thinks about another person’s mental states (e.g., “John thinks that Mary thinks X”).

Although false belief understanding represents an important component in the development of mentalizing skills, passing such tasks cannot be taken as conclusive evidence of an intact theory of mind since performance on them may be mediated by compensatory strategies, such as language or general reasoning abilities (Tager-Flusberg & Sullivan, 1994). Moreover, ASD populations with a verbal mental age of approximately 9 (Happé, 1995) to 12 (Kaland et al., 2008) are almost certain to pass standard first-order tasks of false belief regardless of their chronological age. This delay is relatively large compared to typically developing children who invariably succeed on first-order tasks by 4 to 5 years, and second-order tasks at 6 to 7 years, and show minimal
deviation in terms of the age at which they succeed (Perner & Wimmer, 1985).

Furthermore, the hypothesis that ASD populations may solely rely on linguistic skills or other non-theory of mind strategies to solve, or “hack out”, false belief tasks brings into question whether these individuals possess a genuine awareness of and appreciation for another person’s mind (Happé, 1995).

Another issue of contention among ASD researchers surrounds the admissibility of false belief understanding as a primary index of a functional theory of mind. According to Tager-Flusberg (2001), “the literature on autism often equates performance on a false-belief task to the presence or absence of a theory of mind, reducing what should be a rich, complex, unfolding mentalistic conception of people to a categorical capacity” (p. 161). Indeed, basing theory of mind competence exclusively on a dichotomous pass/fail task is erroneous and restrictive, especially since there are a wide range of abilities that comprise theory of mind (Hutchins, Bonazinga, Prelock, & Talyor, 2008). Consequently, advanced measures that can detect subtle mentalizing abilities and reflect diverse social-cognitive understanding have been developed and applied to ASD populations in recent years (e.g., Happé, 1994; Kaland et al., 2002; Baron-Cohen, Wheelright, Hill, Raste, & Plumb, 2001; Hutchins et al., 2008).

With the introduction of more naturalistic measures, it has now been recognized that theory of mind is a multifaceted construct that can be evaluated using a battery of tasks and is best conceptualized on a continuum of competence, rather than an all or nothing ability (Howlin, 2008). Individuals with high functioning autism or AS tend to fall on the high end of this continuum and exhibit well-developed false belief understanding. Nevertheless, these individuals still have difficulties inferring the mental
Given that deficits in theory of mind are ubiquitous among all populations on the spectrum, attention has been directed to the nature of theory of mind development to ascertain whether mentalizing abilities are largely innate and inflexible or if they can improve over time. Pinpointing the critical precursors to theory of mind remains a controversial topic; however, some developmental research has shown that social-communicative behaviours in early life may predict future theory of mind ability (Hutchins & Prelock, 2008). Charman et al. (2000) highlighted the importance of engaging in pretend play, imitation, and joint attention in the second year of life and suggested that these developmental milestones may signify early manifestations of an infant’s ability to represent the mental states of others. Establishing joint attention, particularly through gesturing to an object of interest (i.e., proto-declarative pointing), demonstrates intentional communication which is considered an antecedent to social-cognitive awareness (Camaioni, 1992). For instance, an infant’s use of declarative pointing at approximately 10 to 12 months has a functional goal of forming a shared perspective with another. By 16 months, typically developing infants make a subtle, yet sophisticated transition in their declarative pointing. Instead of looking to another person immediately after pointing (as if to draw another’s attention to a novel stimulus in his/her environment), the infant will look to another immediately before pointing, which seems to imply a greater appreciation for establishing shared enjoyment or affect with another—a shift that arguably demonstrates a desire to appeal to the internal states (interest/concern) of another (Camaioni, 1992). Disruptions in early episodes of joint
attention, such as shared eye gaze, have been identified in ASD infants. Research has shown that when a speaker identifies a novel word, infants on the spectrum attend much less to their speaker’s direction of gaze to guide word learning compared to typically developing infants (Baron-Cohen, Baldwin, & Crowson, 1997). Baron-Cohen and colleagues (1997) reasoned that the inability to follow another’s gaze could be viewed as part of a broader deficit in appreciating the concerted effort involved in intentional communication and the ability to employ a theory of mind.

Traditionally, theory of mind deficits in ASD populations were believed to be largely predetermined in early childhood since improvements in mental state understanding did not seem to occur when examined longitudinally (Holroyd & Baron-Cohen, 1993; Ozonoff & McEvoy, 1994). More recently, though, through the use of broader and more sensitive measures, significant developmental improvements in theory of mind performance were observed in a sample of 57 children and adolescents with ASD, aged 4 to 14, in a one year span (Steele, Joseph, & Tager-Flusberg, 2003). Participants were administered a battery of theory of mind tasks and, although ASD children and adolescents exhibited mentalizing delays relative to same-aged peers, over two-thirds of the children made advances in theory of mind scores over the course of one year. Steele, Joseph, and Tager-Flusberg (2003) also found that advances made among participants were evenly distributed across the ages sampled, and that autistic children who were under and over the age of 10 showed similar advances in theory of mind performance. Such findings challenge the previously held view that theory of mind abilities are unchanging and further demonstrate that, irrespective of chronological and verbal mental age, ASD populations can improve upon their theory of mind competence.
during the early developmental years and beyond. With theory of mind now generally regarded as an adaptive set of skills, a number of attempts have been made to foster such awareness in children, adolescents, and even adults with ASD by introducing specialized teaching strategies and training programs.

*Interventions to Improve Theory of Mind in ASD Populations*

The inability to impute cognitive states to oneself and others has serious implications in communicative, behavioural, and social domains (Hutchins & Prelock, 2008). For instance, deficits in theory of mind can lead to profound difficulties “in understanding others’ point of view; in modifying speech/behaviour according to social context, in reciprocal communication, abstract understanding/imagination, in understanding social rules (and the need for flexibility in following these rules) and in recognizing the impact of one’s own behaviours or speech on others” (Howlin, 2008, p. 79). It is evident that deficits in theory of mind are highly pervasive and can impede one’s functioning in a wide array of daily situations; however, interventions for populations with ASD, particularly those with AS, are limited and often focus on social skills training (Blackshaw, Kinderman, Hare, & Hatton, 2001).

Of the interventions established to directly enhance theory of mind performance, most of the initial efforts focused on teaching children with ASD to master false belief understanding (Sweetenham, Baron-Cohen, Gomez, & Walsh, 1996). Children in these early studies were presented with modifications to the standard false belief tasks with the goal of facilitating awareness of general mental state concepts. For instance, Bowler and Strom (1998) had children play the protagonist in a series of first-order false belief tasks. Instead of presenting a sequence of events between the Sally and Ann dolls, children
became active participants in each of the false belief scenarios. This firsthand involvement allowed children to understand that an individual can hold a belief that may contradict reality when circumstances, unbeknownst to the individual, happen to change. By using repetition and exaggerating the behavioural and emotional cues that accompany a false belief (i.e., having a confederate explicitly state ‘I played a trick on you, I hid the [object]!’), Bowler and Strom (1998) elicited false belief understanding in both typically developing children \((n = 30)\) and ASD children \((n = 9)\) with an average verbal mental age of 6:0.

Other experimental studies with ASD samples documented significant improvements on the Sally-Ann task with the use of pictorial aids. For instance, in the “picture in the head” strategy, images of Sally’s and Ann’s mental contents were placed directly above the characters’ heads to illustrate the distinct beliefs held by each doll. By employing this strategy, ASD children and adolescents \((M_{age} = 11:6)\) with an average verbal mental age of 6:0 demonstrated a marked increase in ability to pass the Sally-Ann false belief tasks (Sweetenham, Baron-Cohen, Gomez, & Walsh, 1996). Corroborating evidence was found in an older sample by McGregor, Whiten, and Blackburn (1998) who reported that ASD adolescents \((M_{age} = 13:11)\) and adults \((M_{age} = 28:7)\) with an average verbal mental age of 5:8 and 7:6, respectively, also exhibited significant gains in false belief understanding when this strategy was implemented. According to Kerr and Durkin (2004), pictorial aids make an individual’s beliefs appear tangible, which may enhance the saliency of mental representations and reduce the amount of working memory needed to solve theory of mind problems, thereby allowing an individual with ASD to attend more easily to the task at hand.
Similar to the picture in the head strategy, Wellman, Baron-Cohen, Caswell, Gomez, and Swettenham (2002) tested the efficacy of thought bubbles to represent the divergent mental events of characters in the Sally-Ann task. The researchers postulated that, compared to pictures in the head, this pictorial aid would be a more pragmatic teaching strategy since children are commonly exposed to thought bubbles in cartoons, comics, and storybooks. While thought bubbles did improve false belief performance in six of the seven ASD children sampled, there was a limited transfer of the children’s mental state understanding to other theory of mind-related problems (Wellman et al., 2002).

More elaborate training programs ranging from eight days (Hadwin, Baron-Cohen, Howlin, & Hill, 1996) to over four months (Ozonoff & Miller, 1995) have been devised to teach general theory of mind principles to groups of ASD children. In addition to false belief understanding, children were taught social-cognitive skills during these programs to promote awareness of the mental states of others. Both programs noted changes in theory of mind competence among participants from pre- to post-intervention; however, neither study observed sustained improvement in other theory of mind domains, such as the children’s social behaviours and interactions. Researchers have also capitalized on computer-based interventions (Sweetenham, 1996) and virtual reality technology (Mitchell, Parsons, & Leonard, 2007) to help children with ASD improve theory of mind and related skills necessary for successful social interactions.

Despite all of the aforementioned attempts to facilitate theory of mind competence, there is little evidence suggesting that any improvements on task-specific performance extend to other theory of mind domains and naturalistic situations (Howlin,
Furthermore, though ASD populations can learn to pass false belief tasks and acquire an understanding of basic mental state concepts, the compensatory strategies learned through training interventions are generally restricted to the task and fail to generalize from one theory of mind context to another (Wellman et al., 2002). Consequently, there is a need for naturalistic interventions that can influence mentalizing abilities beyond specific training conditions, yet also have a long-term impact on theory of mind competence.

Improving Theory of Mind among ASD Populations in a Naturalistic Context

Language provides the means through which a child can explicitly declare awareness of another’s mental states, which is why communicative ability plays an integral role in theory of mind development and strongly predicts performance on theory of mind tasks (Astington & Jenkins, 1999). Extracting meaning from language is essential for successful communicative exchanges (Parsons & Mitchell, 2002). Since speakers rarely say exactly what they mean, listeners must be able to actively reflect on the context of the conversation to decipher ambiguous utterances. As well, speakers must do their best to avoid ambiguity by selecting relevant information for their listeners’ knowledge state and adapting their intended message to the context of the conversation (Hadwin, Baron-Cohen, Howlin, & Hill, 1997). Moreover, speakers must evaluate what information the listener already knows, what information is new to the listener, and what information is needed for a listener to comprehend a message. Failure to monitor the listener’s knowledge state can result in confusion or boredom if the speaker provides the listener with too little or too much information (Colle, Baron-Cohen, Wheelwright, & van der Lely, 2008).
Similar guidelines for effective communication can be applied to contexts other than face-to-face interactions, such as written discourse. Though research on writing in populations with AS is limited in scope (Delano, 2007), studies that examine the written compositional skills of AS children are needed since the ability to tailor a message to an absent audience reveals social-cognitive awareness and, more specifically, theory of mind competence.

Given that children with AS lack the same level of social-cognitive awareness that typically developing children unconsciously acquire through everyday interactions (Åsberg & Sandberg, 2010), it was hypothesized that visual feedback on a perspective-taking task might provide AS children and adolescents with a compensatory strategy to improve their ability to consider another person’s mind—namely, their reader’s mind—when writing. Previous interventions using pictorial aids, such as the picture in the head strategy and thought bubbles, demonstrated that visual scaffolding could serve as a useful technique to promote awareness of the mental states of others. Therefore, the present study sought to investigate the efficacy of visual scaffolding on a newly-developed, computer-based training intervention that aimed to foster perspective-taking in children and adolescents with AS in a written context.

The Present Study

*Perspective-Taking in Written Communication*

Taking into account a reader’s mind—often referred to as audience awareness—is a complex representational act and a hallmark of experienced writing (Holliway, 2004). According to Bereiter and Scardamalia (1987), there are two processes of text composition that distinguish novice from expert writers. Novices engage in a knowledge
telling process of writing, where relevant content is retrieved from memory and directly transcribed into text. Since the content undergoes no transformation, the writer fails to adapt his or her message to establish a communicative context for the reader. Consequently, this process of writing is egocentric and serves only the needs of the writer. Once basic writers master the lower-level aspects of writing and develop a sense of automatization and proficiency with the knowledge telling process, they advance to a qualitatively distinct form of writing called knowledge transforming. Characterized by goal-directed thinking and careful appraisal of the text, writers who engage in knowledge transforming create an internal assessment of their audience and compose texts with information-rich descriptions to facilitate understanding. Moreover, expert writers who employ this latter process move from egocentric language to more decentered, reader-based language and direct their attention to more advanced and cognitively taxing aspects of writing, such as consideration for the informational needs of a reader (Carvalho, 2002).

Sommers (1980) proposed that, to meet the informational needs of a reader, a writer must be able to simultaneously integrate two mental representations of his or her audience during text composition. The first representation is of the personal communicative intent (i.e., establishing ‘What do I want to say to my reader?’), while the second representation is of the text produced (i.e., establishing ‘What have I actually written?’). When a writer perceives a mismatch between these two representations, revisions are necessary to achieve a greater shared perspective with one’s audience and to improve the communicative quality of the intended message.

Building upon Sommers’ (1980) theory, Traxler and Gernsbacher (1992) suggested that, while both representations are imperative for writers to effectively convey
a message, they are not sufficient. A third representation must also be implemented; that is, the representation of how the writer’s audience will interpret the text. Young writers, in particular, have difficulty applying this third representation to their written work because they already struggle with the heavy information-processing demands of writing, which leave few cognitive resources available for thinking about the mind of their reader (Bonk, 1990).

The Development of Perspective-Taking in Writing in Neurotypical Children and Children with AS

Before young writers can successfully integrate all three representations and establish a shared perspective with their readers, a rudimentary level of social-cognitive awareness must first be achieved. Research has shown that the development of social knowledge is strongly associated with written communication skills (Kroll, 1985) and that children who respond more efficiently to their conversation partner’s informational needs possess higher levels of theory of mind (Resches & Perez Pereira, 2007). Typically developing children under the age of six demonstrate difficulty in recognizing the necessary amount of linguistic information to guide understanding in written text. Although pre-literate neurotypical children can think about their own and other people’s minds, they still underestimate the importance of communicative clarity in their written compositions and are unaware that ambiguity within a text can lead to failures in comprehension (Beal, 1996). Nevertheless, by six (Nilsen, Graham, Smith & Chambers, 2008) or seven (Robinson & Apperly, 2001) years of age, children begin to develop sensitivity to the informational needs of an absent audience and are able to acknowledge discrepancies that may exist between the message’s communicative intent, the possible
interpretations made by a reader, and the actual message that was communicated (Holliway, 2004).

In contrast to typically developing peers, less is known about the development of perspective-taking in written communication among AS children. However, research on spoken communication in autistic populations has found that children on the spectrum engage in more egocentric narratives and fail to appropriately adapt their speech to a specific audience (Colle et al., 2008). For instance, they may converse with friends and strangers in a similar manner and demonstrate an inadequate ability to monitor the informativity of their communicative exchanges. In fact, failing to recognize the necessary amount of linguistic information to achieve a communicative goal has been found to be a widespread impairment in ASD, even among high functioning autistic individuals (Nadig, Vivanti, & Ozonoff, 2009).

Assessing the Perspective-Taking Skills of Neurotypical and AS Children in Verbal and Written Contexts

One of the most common methods of studying perspective-taking skills in young children or adolescents is through the use of a referential communication paradigm. Referential communication refers to an individual’s ability to establish a shared perspective with another by using cues to guide communicative behaviour. This experimental design requires a speaker/writer (i.e., the person who conveys a message) to effectively communicate the distinguishing properties of a stimulus to a listener/reader (i.e., the person who receives the message), without any visual access to the stimulus being described. In a study by Glucksberg and Krauss (1967), a referential communication paradigm was created to examine the communicative behaviours of
students in the third, fifth, seventh, and ninth grade. In each testing trial, two same-aged participants were positioned on opposing sides of an opaque screen. The task of one participant was to verbally describe irregularly-shaped figures to the other participant in a way that would permit the listener to appropriately select the correct figure from a series of similar figures. Both participants were able to openly converse throughout the testing trials. While older children were more successful than younger children at providing communicative clarity for their partner, Glucksberg and Krauss (1967) found that younger children provided inadequate descriptions and failed to adapt their responses in a helpful manner. Moreover, the authors concluded that early verbal communication was marked by self-based thinking and that, once children acquire the perspective of their conversational partner, language became more other-based.

Empirical Research on Perspective-Taking and Referential Communication Skills

Deficits in the referential communication skills of ASD populations have been primarily attributed to limitations in theory of mind and an inability to engage in perspective-taking (Dahlgren & Sandberg, 2008). The earliest investigation of referential communication skills in children and adolescents with high functioning autism was reported by Loveland, Tunali, McEvoy, and Kelley (1989). Autistic \( n = 13 \) and Down’s syndrome \( n = 14 \) participants, with an average verbal mental age of approximately 6, were taught how to play a simple board game and then instructed to teach someone else ten target information items about the game. The response adequacy for each piece of target information explained by participants was measured on a 5-point likert scale, ranging from no response or irrelevant response (1) to a greatly elaborated, well-produced response (5). Compared to Down’s syndrome participants, children and
adolescents with autism required greater prompting by a learner to explain the ten target information items and produced responses of lower adequacy when communicating information to a learner. Overall, responses of autistic participants were significantly shorter and less informative than those of speakers with Down’s syndrome. Loveland et al. (1989) concluded that the impoverished referential communicative skills of autistic participants supported the theory of mind deficit account of ASD, and that a major problem for the autistic speaker resulted from an inability to anticipate his or her listener’s perspective. Furthermore, once the learner prompted autistic speakers to explain a specific piece of target information (i.e., “Tell me where to start the game”), they were cued into the informational needs of the learner and could then supply the appropriate target information.

In a related study, Dahlgren and Sandberg (2008) more recently examined the referential communication skills of 30 children with high functioning autism, aged 7 to 14 years old. Participants were matched on chronological age, mental age, verbal IQ, and performance IQ to 30 non-disabled peers. Similar to Glucksberg and Krauss’s (1967) paradigm, participants were instructed to verbally describe one of sixteen cards so that a naïve listener could correctly identify the target card from a series of detractors. The general findings were convergent with those from Loveland and her colleagues (1989); that is, children with high functioning autism were under-informative in their referential descriptions of relevant card characteristics and were less efficient in conveying information to their listener than the comparison group. Scores of referential efficiency were obtained by calculating the total number of relevant features described minus the total number of irrelevant features described, divided by the maximum possible number
of relevant features. Dahlgren and Sandberg (2008) noted that theory of mind competence was significantly correlated with referential efficiency scores ($\rho = 0.47$). Moreover, children who succeeded on first-order and second-order theory of mind tasks were not only more efficient in their communication, but also provided their listener with a higher proportion of relevant information compared to children who failed first-order tasks.

Though referential communication paradigms have traditionally been used to study perspective-taking in verbal communication, such tasks can also offer insight into the development of an individual’s ability to take the perspective of a reader when composing a text. Perspective-taking in non-interactive contexts, such as writing, is a considerably more difficult task since spoken communication is a collaborative process and both the speaker and listener are able to engage in real-time exchanges to achieve mutual communicative understanding (Holliway, 2010). For instance, when a listener is unaware of the speaker’s intended message, he or she can request clarification and, likewise, speakers can request feedback from listeners to determine whether or not their intended message was correctly understood. Unlike the relationship between listeners and their speakers, readers are unable to request such clarification from their writers. Therefore, to successfully convey their messages, writers must independently envision how readers will interpret their text by preemptively establishing a mental representation of their readers’ informational needs and being aware of such needs during text composition.

Traxler and Gernsbacher (1992) applied the referential communication paradigm to a written context and assessed whether feedback from readers could improve writers’
ability to understand how their descriptive texts were interpreted. In their first experiment, a group of university-aged students were instructed to write descriptions of geometric figures so that anonymous readers could select the correct figure from a series of similar-looking distracters. Half of the writers received feedback from two readers on how well their descriptions guided the selection of the correct figure and half of the writers did not. The group of writers who received feedback were provided with information about the number of readers (i.e., none, one, or two) who successfully matched their written description to the target geometric figure. Upon receiving or not receiving feedback, writers were told they could modify the descriptions of their figures. Traxler and Gernsbacher (1992) predicted that after three writing and revision sessions the feedback provided to half of the writers would allow this group to form better representations of their readers and, in turn, improve the informativeness of their descriptions. It was also predicted in a second experiment that the effects of feedback would transfer to a novel writing task. Results from the study fell in line with the authors’ predictions; that is, when writers received feedback, albeit minimal, the communicative effectiveness of their descriptions were significantly improved even on the novel writing task. However, no significant improvements were observed in the descriptions of writers who received no feedback.

A subsequent study provided further support for the efficacy of feedback in written settings. Traxler and Gernsbacher (1993) found that a sample of university-aged writers who, in addition to describing geometric figures performed their readers’ task, were able to revise their descriptions more successfully than matched controls because, having been “in their readers’ shoes”, they arguably had a better understanding of their
reader’s perspective and their informational needs. Using a similar referential communication design, Holliway (2004) investigated whether a younger sample of fifth- and ninth-grade writers could compose and tailor written descriptions of geometric figures to the needs of their readers, like in Traxler and Gernsbacher’s (1992; 1993) studies. Students were randomly assigned to one of three perspective-taking conditions: a feedback only condition, where writers received feedback as to the number of readers who correctly matched their descriptions to the appropriate geometric figure, a rating other condition where writers evaluated the effectiveness of others’ written descriptions, and a reading-as-the-reader condition where writers performed an identical matching task that their readers performed. A repeated measures analysis revealed that writers in both the fifth- and ninth-grade displayed significant improvements in their descriptions from the first to the third writing session under the reading-as-the-reader condition \( F(4, 296) = 2.96, p = .019 \). According to Holliway (2004), these results suggested that when young writers read as their readers, they began to acquire the subtleties of reader awareness by directly experiencing their reader’s process, which could effectively aid them in the construction of descriptive texts for an intended audience.

**The Present Study: Purpose and Objectives**

There is a paucity of well-supported theory of mind interventions for ASD children, particularly for children with AS (Brent, Rios, Happe, & Charman, 2004). Moreover, it remains unclear whether performance on theory of mind tasks can not only be fostered and maintained over time, but can generalize to other useful areas of functioning that require consideration for another’s perspective, such as communicative exchanges.
Examining the written communication skills of children provides researchers with a useful window into how well young writers can employ theory of mind and reflect upon the perspective of their reader when writing (Colle et al., 2008). Previous research has shown that, in addition to the heavy cognitive demands associated with producing reader-based text, young writers struggle with writing for an audience due to their tendency to think in an egocentric manner. Despite having underdeveloped and limited social-cognitive awareness, some evidence suggests that emerging writers as young as five years old can show signs of decentered writing and the capacity to anticipate their readers’ informational needs when the appropriate intervention is implemented (Wollman-Bonilla, 2001). Such findings demonstrate that writing interventions can be successfully applied to young children and used to activate analogous theory of mind processes that well-established writers employ, which are usually not taken into account during the early stages of writing. Therefore, the present study sought to investigate whether a multi-component referential communication task could provide young AS children and adolescents with a compensatory strategy to facilitate reader awareness and significantly improve their ability to consider the informational needs of an audience in a written context.

Referred to as the “Gruffees Task”, this newly-developed computer-based paradigm asks children to construct unconventional figures (i.e., Gruffees) using an assortment of body parts that vary on two out of three possible dimensions (i.e., shape, colour, and/or size). Children dictate instructions on how to build their Gruffee so that a confederate in another room can reproduce the image without having actually seen it. Since AS populations exhibit deficits in theory of mind and have difficulty representing
another’s perspective, it is hypothesized that children with AS will initially underestimate the amount of linguistic information needed for a confederate to successfully build a Gruffee, which will result in the production of an inaccurate replica. However, the feedback group, which will be able to visually compare their Gruffee to the one built by a confederate on the basis of their dictated instructions, is expected to significantly outperform the control group who receive no form of visual feedback. Furthermore, children who receive visual feedback from the confederate (i.e., an image of the reproduced Gruffee) are expected to make use of their reader’s knowledge state and significantly improve the overall descriptiveness and accuracy of their instructions on subsequent training trials, relative to the non-feedback group.

Aside from the primary hypothesis, the present study attempted to explore two additional questions of interest. First, when the informational needs of the confederate change, will children and adolescents with AS be able to take into account the confederate’s change in perspective and modify their instructions accordingly? The purpose of asking this question is to discern whether participants who receive feedback simply learn a compensatory strategy; that is, to always provide greater detail in their instructions, rather than to truly represent their reader’s knowledge state. A second question of interest is: will any gains in perspective-taking acquired from the referential communication task transfer to a completely novel task that also requires the consideration of another’s perspective?

Method

Participants

A total of thirteen children and adolescents (11 males, 2 females) with a formal
diagnosis of Asperger’s syndrome served as participants in the present study. The disproportionate ratio of males to females was anticipated, since AS is approximately four times more common in males (Fombonne, 2003). Participants were divided into two testing conditions; an experimental (feedback) condition comprised of 9 participants (8 males, 1 female) and a control condition comprised of 4 participants (3 males, 1 female). Their chronological ages (CA) ranged from 7:0 to 13:1 years old ($M = 10.5, SD = 1.9$). Both conditions were matched on CA [$t(11) = .26, p = .80$]. Two male participants originally in the experimental condition were excluded from the study due to incomplete data.

According to participants’ parents, 8 received a formal diagnosis of Asperger’s from a psychiatrist, while 3 were diagnosed by a pediatrician and 2 by a psychologist. Parents also revealed comorbid diagnoses, including Central Auditory Processing Disorder ($n = 4$), Attention-Deficit Hyperactivity Disorder ($n = 3$), learning disabilities ($n = 3$), Major Depressive Disorder ($n = 1$), and/or Obsessive-Compulsive Disorder ($n = 1$). The majority of participants lived with both parents (92%) and there were no significant group differences in terms of the mother’s [$\chi^2(3, N = 13) = 1.66, p = .65$] or father’s [$\chi^2(4, N = 13) = 2.61, p = .63$] level of education.

All participants were recruited via one of two routes: (1) the Social Skills Group for Children with Asperger’s and their Parents at the Centre for Addiction and Mental Health (CAMH) or (2) the Geneva Centre for Autism.

**Design**

The study was a pre-intervention/post-measurement design involving three testing sessions. The first two sessions, each 45 minutes to 60 minutes in length ($M_{interval} = 2.38$
days apart, *range* = 0–7 days), involved a pre-test measure, training trials, tests of visual and perceptual ability, receptive language ability, theory of mind ability, and post-test measures. The third session involved delayed post-test measures to assess whether any improvements from the training trials could be maintained over time, as well as whether any improvements could be transferred to an unfamiliar, non-computer based, instruction-giving task (i.e., describing a magic trick). This final testing session was conducted an average of 6.7 weeks (*range* = 5.86–8.99 weeks) following the second session and took 30 to 45 minutes.

**Materials**

*General Testing Materials*

Two laptops, one for the experimenter to display testing materials to participants and another for a confederate to build Gruffees, were used throughout testing sessions. A book of pre-constructed Gruffees was propped on a bookstand beside the experimenter’s laptop. The instructions dictated by participants on how to build Gruffees were saved to a USB memory stick and transferred from the experimenter’s laptop to the confederate’s laptop in the experimental condition. A standard stopwatch timed the Beery VMI-5 during the first testing session.

*Referential Communication Tasks*

All visual displays (i.e., the Gruffees task, the change in perspective-taking tasks, and the close transfer tasks) were created on Microsoft® PowerPoint™ and served as the primary means through which referential communication skills were evaluated.

*The Gruffees task.* The Gruffees task required participants to build odd-shaped, monster-like figures (i.e., Gruffees) composed of eight distinct body parts (see Appendix
A). On each Gruffees display, a coloured “body” was situated on the right-hand side of the screen in front of a white background and surrounded by a border, each side of which was a different colour. The border provided a reference point for participants who had difficulty identifying spatial locations. There were six grey compartments on the left-hand side of the screen. Each compartment contained a different body part that had either two or four variants, which also varied across two (out of three possible) dimensions. For instance, the body parts in a given compartment could vary based on colour (e.g., red vs. blue) and size (e.g., big vs. small), colour and shape (e.g., round vs. pointy), or size and shape. A total of 18 body parts were displayed; however, only eight could be selected and arranged on the body to construct a Gruffee.

Change in perspective-taking task. At the beginning of the change in perspective-taking task, a confederate entered the testing room and viewed a blank Gruffees display where four of the 18 body parts were highlighted (see Appendix B). The confederate was told that the highlighted body parts had been pre-selected to build a Gruffee, but no additional information was provided as to how any of the four parts would be arranged on the Gruffee’s body. This essentially provided the confederate with a hint. If participants were sensitive to the fact that the confederate now had fewer informational needs, they should describe the pre-selected body parts with less detail when dictating instructions. In total, two change in perspective-taking tasks based on different pre-constructed Gruffees with different highlighted body parts were administered to participants.

Close transfer tasks. In the first close transfer task an empty three-dimensional room was displayed on the experimenter’s screen (see Appendix C). Bedroom furniture items varying in colour, shape, and/or size were situated around the perimeter of the
room. Similar to the Gruffees task, only eight of the furniture pieces could be selected and uniquely arranged to create a bedroom scene. An empty outdoor scene accompanied by 18 picnic-related items was displayed on the experimenter’s screen in the second close transfer task (see Appendix D). The items varied in colour, shape, and/or size and eight could be selected and uniquely arranged by participants to create a picnic scene. Both close transfer tasks examined whether any gains from the training trials could be transferred to an unfamiliar, but qualitatively similar, instruction-giving task.

Distant transfer task. Participants were presented with a magic trick as the distant transfer task. Using three plastic cups (red, yellow, and blue) and a pile of pompoms that varied in colour and size, the experimenter demonstrated a trick in which a small white pompom appeared to magically penetrate one of the solid cups (see Appendix E for a complete description of the magic trick). Once it was revealed to participants that a secret pompom was hidden in the cup, they were asked to repeat the eight general steps until they could perform the trick without any assistance. The main objective of the task was not to evaluate the memory recall of participants, but to evaluate their ability to describe the subtle, yet critical, intricacies of the trick (e.g., selecting a small white pompom from the pile, flipping the cups quickly so that the secret pompom does not fall out, etc.) to a confederate who had never seen the trick before.

In addition to the materials associated with the Gruffees paradigm and related tasks, participants received a battery of psychometric measures during the first and second testing sessions. These measures were presented to participants in the following order: (1) the Beery™ Visual-Motor Integration Developmental Test of Visual Perception (Beery VMI-5), (2) a revised version of Happé’s (1994) Strange Stories Test, and (3) the
Peabody Picture Vocabulary Test (PPVT-4). Two supplementary measures were completed by the primary parent/guardian of each participant. These measures included: (4) a demographics questionnaire and (5) the Theory of Mind Inventory. All five measures are described below.

**Control Measures**

*Beery™ Visual-Motor Integration Developmental Test of Visual Perception, fifth edition* (Beery VMI-5; Beery & Beery, 2004). The Beery VMI Visual Perception test is a standardized 30-item task that measures the extent to which children and adolescents, aged 2 to 18, can integrate their visual and perceptual abilities. In this task, respondents are asked to locate a test stimulus among a series of distracter figures that are not exactly the same and that increase in difficulty as the task progresses.

*Revised version of the Strange Stories Test* (O’Hare, Bremner, Nash, Happé, Pettigrew, 2009). The Strange Stories Test consists of a set of vignettes representing everyday social scenarios in which characters make verbal utterances that they do not literally mean. Based on Happé’s (1994) Strange Stories Test, a shortened version was used to assess advanced theory of mind in populations on the autism spectrum. O’Hare and colleagues (2009) selected twelve of Happé’s (1994) twenty-four original stories to represent one of each story type: lie, white lie, misunderstanding, sarcasm, persuasion, contrary emotion, pretend, joke, figure of speech, double bluff, appearance/reality, and forget (see Appendix F for an example). Each story was paired with an accompanying image to reduce the loading on memory skills. After each story was read aloud by the experimenter, respondents were asked to identify the underlying motivations behind the characters’ actions or words, which could only be accurately interpreted by appreciating
the context of the social situation. Responses for each story were recorded on a separate answer sheet and scored on a scale from 0 to 2 as incorrect, partially correct, or fully correct based on pre-established criteria. Total scores ranged from 0 to 24. The task took approximately 10 to 15 minutes to administer.

*Peabody Picture Vocabulary Test, fourth edition* (PPVT-4; Dunn & Dunn, 2007). The PPVT-4 is a standardized, English-based, receptive vocabulary task where the examiner says a stimulus word aloud and examinees are asked to identify one of four images that best corresponds with that word. Examinees begin on a word set that is age-appropriate, but advance to sets that are progressively more difficult. The PPVT-4 took approximately 10 to 25 minutes to administer.

*Demographics questionnaire.* A paper-and-pencil demographics questionnaire requested information from the parents of participants about the gender, date of birth, level of education, and marital status of both parents. Another section requested information related to their child’s AS diagnosis, any treatments accessed and/or received over the years prior to and following their child’s diagnosis, and any other formal diagnoses the child has or previously had aside from AS. The demographics questionnaire took parents approximately 5 minutes to complete.

*Theory of Mind Inventory* (ToMI; Hutchins, Prelock, & Bonazinga, 2010). The ToMI is an updated version of the Perception of Children’s Theory of Mind Measure-Experimental Version (PCToMM-E; Hutchins et al., 2008) and includes 48 items designed to measure a range of theory of mind competencies in children, as determined by their parents or primary caregivers. Test items cover a range of topics pertaining to the thoughts and feelings of children in real-life social situations. Sample items from the
ToMI can be found in Appendix G. Respondents were instructed to read each statement carefully and indicate, using a vertical hash mark, the degree to which their child would engage in a particular social response on a continuous scale from “definitely not” to “definitely”. The point at which the hash mark crossed the continuum was measured using a standard engineering 30-feet-per-inch-scale ruler. Responses for each item were individually scored using the ruler and could range from 0 to 20. Higher values reflected greater degrees of certainty that the child possessed mental state awareness in a given social situation. An aggregate score of theory of mind competence was obtained by adding the item scores together.

The ToMI has undergone a national field trial with preliminary analyses indicating excellent psychometric properties for evaluations of test-retest reliability (for short and long time lags), internal consistency, convergent criterion-related construct validity and contrasting-groups criterion-related construct. In addition, recent examinations of validity indicated the expected relationships between social skills and ToMI scores when administered to a sample of adolescents with ASD. ToMI scores also distinguished individuals on the basis of verbal ability (Lerner, Hutchins, & Prelock, in press). The ToMI took parents approximately 10 to 15 minutes to complete.

Procedure

The experimenter tested participants individually in a quiet room at their home or at the Ontario Institute for Studies in Education at the University of Toronto. The primary parent/guardian completed the demographics questionnaire and ToMI. A confederate sat in an area some distance away from the testing room during all sessions and participants were introduced to her before the study began. Inside the testing room the experimenter
sat directly beside participants and, before testing commenced, participants were randomly assigned to an experimental or control condition.

First Two Sessions

Participants received simple, introductory tasks to ensure they could manipulate objects on a computer screen and could identify the general locations of an object, since these basic skills were prerequisites for Gruffee-building and other related tasks. The experimenter opened a blank Gruffees display following the completion of these introductory tasks and participants were asked to recreate a pre-constructed Gruffee which served as a practice trial. If a particular body part was not placed in its proper location, the experimenter prompted participants to correct the error.

Gruffees pre-test. The experimenter selected a second pre-constructed Gruffee for participants to recreate. Once participants successfully built the image, they were reminded of the confederate sitting outside the testing room: “Do you remember my friend, [confederate’s name]? Well she really wants to build Gruffees and she wants to make them look exactly like the one that you built. I need you to come up with some instructions so that she can build a Gruffee that looks just like yours. The thing you have to remember, though, is that [confederate’s name] won’t be able to see a picture of what your Gruffee looks like.” To highlight the visual context shared with the confederate, participants were shown a blank Gruffees display. Next, participants were asked to dictate instructions for the confederate. Dictation was used in order to reduce the cognitive demands associated with writing. The experimenter recorded the instructions and reviewed them with participants. Any revisions initiated by participants were made prior to saving the file to a USB memory stick.
For participants in the experimental condition, instructions were immediately delivered via the USB memory stick to a confederate who then built the pre-test Gruffee. If written instructions were ambiguous, the confederate was encouraged to select the incorrect body part and/or incorrect location of a body part to visually represent shortcomings in the writing. The dictated instructions for this Gruffee served as a pre-test measure of the written compositions of participants in both testing conditions.

Experimental participants were briefly introduced to visual feedback when the confederate returned the USB memory stick and a quick comparison was made between their pre-test Gruffee and the confederate’s Gruffee. However, control participants were told that more Gruffees would be built before their instructions were passed along to the confederate: “You will get to see how [confederate’s name] does at the very end of all our games.”

*Training trials.* All participants proceeded to construct their own personalized Gruffee comprised of eight body parts. As in the pre-test trial, instructions were dictated by participants and recorded by the experimenter. Those in the experimental condition delivered their instructions via the USB memory stick to the confederate, while those in the control condition did not. When the USB memory stick was returned, the participants’ original Gruffee and the confederate’s recreated Gruffee were placed side-by-side on a comparison screen, with the written instructions directly below. Participants in the experimental condition were asked the following questions: “Are they the same?” and “Why do you think this one [point to the confederate’s Gruffee] turned out different?” If participants failed to provide an adequate response, they were prompted with the question: “Was it because [confederate’s name] made a mistake or because the
instructions were not clear?” The experimenter then reviewed each of the instructions with participants, drawing their attention to any discrepancies that existed between the two Gruffees and assisting them with edits to clarify their instructions (i.e., “Did [confederate’s name] get that right? [If not] What could you have said to make this the same?”). This first training trial provided those in the experimental condition with feedback, both visual (i.e., an image of the reproduced Gruffee) and verbal (i.e., scaffolded editing of the instructions), as to how well their written instructions guided the confederate’s Gruffee-building.

For participants in the control condition, their Gruffee with corresponding instructions was copied to the comparison screen; however, they received no visual feedback from the confederate or verbal feedback from the experimenter. Instead, their instructions were reread, one at a time, while the experimenter asked: “Is this clear?” and “Is there anything you would like to add or change?” in order to control for the time spent on task.

A second training trial was conducted in which all participants built another individualized Gruffee, dictated instructions for a confederate, and either received feedback (experimental condition) or simply reviewed their instructions (control condition). The Beery VMI-5 was administered to participants in-between training trials.

Immediate Post-Tests

Gruffees post-test. Participants constructed a standardized Gruffee, which served as an immediate post-test measure to evaluate whether the written compositions of experimental participants were significantly improved compared to controls. The protocol for the post-test was identical to the pre-test.
**Change in perspective-taking task.** Participants were presented with a perspective-taking task in which the confederate entered the testing room and was told the following: “We wanted to give you a little hint for this Gruffee that we are going to build for you. See these body parts that are inside the grey boxes [point to the highlighted body parts on the screen]. These are body parts that we are definitely going to use in the Gruffee.” The confederate exited the room and participants were shown the pre-selected Gruffee that had four body parts which were familiar to the confederate. Participants were asked to build the Gruffee; however, prior to dictating instructions, the experimenter asked a memory control question: “Before you make your instructions, can you show me which shapes [confederate’s name] knows about?” The instructions were then dictated by participants and reviewed with the experimenter.

**Close transfer task.** The first close transfer task, an empty room with accompanying furniture, was displayed on the experimenter’s computer screen and participants were told: “Just like the Gruffee, you will get to build the bedroom using different pieces. You can make your bedroom look however you want.” Using eight of the 18 furniture items, participants constructed an individualized bedroom scene and dictated instructions for the confederate. The Strange Stories Test and PPVT-4 were administered after participants completed the first close transfer task.

**Delayed Post-Tests**

The third testing session, on average 6.7 weeks following the second session, evaluated whether any improvements from the training trials were maintained and could be transferred to a novel task—the distant transfer.

**Maintenance tasks.** Participants performed three maintenance tasks and
instructions were dictated and reviewed following each task. First, participants constructed a pre-selected Gruffee which served as a delayed post-test measure. Second, the confederate entered the testing room and was given a hint regarding four different body parts that were pre-selected to construct a Gruffee in the second change in perspective-taking task. Third, participants received the second close transfer task in which an individualized picnic scene was constructed from eight of the 18 items.

*Distant transfer task.* A distant transfer task was the final measure of the third session. Participants sat across from the experimenter as a magic trick was demonstrated. A small white pompom was placed on top of an upside-down blue plastic cup, adjacent to two other cups. The experimenter said: “I’m going to make this pompom magically go through the blue cup. Watch!” The outside cups were stacked on top of the blue cup. The experimenter waved his hands over the cups, tapped the stack, and lifted the stack to reveal the “fallen” pompom. After demonstrating the trick, the experimenter explained the trick to participants and asked them to reproduce the eight general steps. If participants forgot a step, they were prompted by the experimenter (i.e., “What comes next” or “Are you sure?) or given explicit instructions. Participants were then asked to perform the trick a second time with little to no prompting. Once the general steps of the trick were performed without assistance, participants dictated instructions to the confederate: “[Confederate's name] has not seen this trick yet. Describe it so that she could perform the same trick, using all the same materials. Just like before, you tell me the instructions and I will type them out.” Participants were informed they could repeat the magic trick while dictating instructions.

*Scoring*
Four outcome variables were coded to evaluate performance on the Gruffees task, the change in perspective-taking tasks, and the close transfer tasks. Scores were obtained from each task by assessing whether participants successfully identified two variables of interest (objects and locations) based on two types of detail (necessary detail only and necessary plus additional detail). The outcome variables for each of the three tasks were as follows: (1) necessary detail provided for objects, (2) necessary plus additional detail provided for objects, (3) necessary detail provided for locations of objects, and (4) necessary plus additional detail provided for locations of objects. Necessary details were defined as features required to accurately identify objects or locations of objects. Necessary plus additional details were defined as miscellaneous features not essential for accurate identification.

The magic trick instructions from the distant transfer task were coded according to three distinct categories of description: (1) general, (2) specific, and (3) miscellaneous. General descriptions refer to eight general steps that comprise the magic trick (e.g., hiding the pompom, stacking the cups, etc.). Specific descriptions refer to additional instructions that were demonstrated by the experimenter and were critical for the correct execution of the magic trick (e.g., describing which cup to hide the pompom in, the order in which the cups needed to be stacked, etc.). Miscellaneous descriptions refer to extraneous instructions that were not critical to the execution of the magic trick and were not demonstrated originally by the experimenter (e.g., tapping the cup a specific number of times before revealing the hidden pompom). All tasks were scored by a second rater who was not involved in the testing process and who was blind to whether participants were in the experimental or control condition. See Appendix H for a detailed account of
how tasks were coded and scored.

Results

The results of thirteen AS children and adolescents are presented in five sections. The first section describes the general characteristics of participants. The second presents the results of their instructions immediately after the training trials. The third presents group comparisons in the first perspective-taking task and the close transfer task. The fourth examines whether any improvements from the training trials were maintained over time. The fifth investigates whether any improvements from the training trials were transferred to an unfamiliar, non-computer based, instruction-giving task (i.e., the distant transfer task).

Equivalence of Experimental and Control Conditions

Participants in the experimental condition \((n = 9)\) had a mean CA of 10 years, 6 months \((SD = 1:6)\). They were assessed on the Beery VMI-5 for their visual and perceptual abilities \((M = 106.44, SD = 17.78)\) and on the PPVT-4 for their receptive language ability \((M = 112.67, SD = 16.88)\). Theory of mind competence was assessed on the Strange Stories Test \((M = 64.35, SD = 24.13)\) and the ToMI \((M = 67.15, SD = 11.53)\).

The second group, a control condition, was comprised of four participants. They presented the following characteristics: CA \((M = 10:3, SD = 2:6)\), visual and perceptual abilities \((M = 108.75, SD = 18.26)\), receptive language ability \((M = 109.25, SD = 14.82)\), Strange Stories Test \((M = 65.63, SD = 14.98)\), and ToMI \((M = 74.79, SD = 12.66)\). No statistically significant group differences existed on any of the variables measured \((t\text{-tests}, p > .05)\). A complete summary of participant characteristics are presented in Table 1.
Table 1. *Participant Characteristics*

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<th>Feedback</th>
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<tr>
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<tr>
<td>Gender(^a)</td>
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<tr>
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<td>2:6</td>
<td>(t(11) = .26, p = .80)</td>
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<td></td>
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<td>(M)</td>
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<td>(SD)</td>
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<td>(M)</td>
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<td>(SD)</td>
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<td>14.82</td>
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<td>Strange Stories(^e)</td>
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<td>(SD)</td>
<td>11.53</td>
<td>12.66</td>
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</tbody>
</table>

*Note.* \(^a\)Gender (Male/Female); \(^b\)Chronological Age (years:months); \(^c\)Beery Visual-Motor Integration Developmental Test of Visual Perception, expressed in standard scores \((M = 100, SD = 15)\); \(^d\)Peabody Picture Vocabulary Test, expressed in standard scores \((M = 100, SD = 15)\); \(^e\)Revised Version of the Strange Stories Test (Percentage); \(^f\)Theory of Mind Inventory (Percentage).
Immediate Post-Test

Four analyses of covariance (ANCOVAs) were performed to determine whether a statistical mean difference existed in the written compositions of participants who either received or did not receive concrete visual and verbal feedback, controlling for pre-test scores. Participants were tested at the beginning of the first session (Gruffees pre-test) and at the end of training trials (immediate Gruffees post-test). Each of the four ANCOVAs assessed a specific facet of participants’ written compositions.

The distributions of scores for the four outcome variables on the pre-test and immediate post-test were examined and all normality assumptions were met. Berry VMI-5 standard scores, PPVT-4 standard scores, Strange Stories Test scores, and ToMI scores were not significantly correlated with any of the four pre-test or immediate post-test outcome variables ($p > .05$). Consequently, none of these measures were added to the model as covariates.

Preliminary analyses evaluated the homogeneity of variance assumptions and the homogeneity of regression slopes assumptions. Levene’s test was not found to be violated among three of the variables; however, scores for the necessary plus additional detail provided for the locations of Gruffee body parts failed Levene’s test and, therefore, the homogeneity of variance assumption was violated for this variable. The homogeneity of regression slopes assumption for the four outcome variables revealed the relationships between the grouping variable (testing condition) and three of the covariates (i.e., pre-test scores for necessary detail provided for Gruffee body parts, necessary plus additional detail provided for Gruffee body parts, and necessary plus additional detail provided for locations of Gruffee body parts) were non-significant. However, the interaction between
the grouping variable (testing condition) and the pre-test scores for the necessary detail provided for locations of Gruffee body parts (covariate) was shown to be significant and, therefore, failed to meet the assumption. Despite the assumptions not being met for two of the four variables, both were included in the present analysis for exploratory purposes.

Four ANCOVAs for the immediate post-test were performed with pre-test scores used as covariates (see Table 2). The results indicated that scores for the necessary plus additional detail provided for locations of Gruffee body parts were found to significantly differ among the experimental \((M = 25.34, SE = 2.02)\) and control \((M = 16.48, SE = 3.04)\) conditions, when controlling for pre-test scores, \(F(1, 10) = 5.84, p = .04, \eta^2 = .37.\)

Immediate post-test scores for the necessary detail provided for Gruffee body parts \([F(1, 10) = 27.88, p = .00, \eta^2 = .74]\) and location of Gruffee body parts \([F(1, 10) = 5.91, p = .04, \eta^2 = .37]\) were also significantly different among testing conditions, when controlling for pre-test scores. The mean immediate post-test scores for necessary detail provided for Gruffee body parts in the experimental and control condition were 97.31\% \((SE = 1.69)\) and 81.04\% \((SE = 2.56)\), respectively. The mean immediate post-test scores for necessary detail provided for the location of Gruffee body parts in the experimental and control condition were 87.57\% \((SE = 4.96)\) and 65.46\% \((SE = 7.51)\), respectively. The magnitudes of the effect sizes for each of the analyses were strong and indicated that 37\% to 74\% of the variance in immediate post-test scores were explained by group differences, when pre-test scores were statistically controlled. No significant mean differences were reported among the two testing conditions on the immediate post-test scores for the necessary plus additional detail provided for Gruffee body parts, when controlling for participants’ pre-test scores, \(F(1, 10) = 1.21, p = .30, \eta^2 = .11.\)
Table 2. Immediate Gruffees Post-Test: Adjusted Means and Standard Errors of the Outcome Variables for the Experimental and Control Conditions

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Feedback</th>
<th>Control</th>
<th>$F$ (1, 10)</th>
<th>$p$</th>
<th>$\eta^2$</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>($n = 9$)</td>
<td>($n = 4$)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Body Parts: Necessary Detail$^a$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
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<td>81.04</td>
<td>27.88</td>
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<td>.74</td>
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<td>Locations of Body Parts: Necessary Detail$^b$</td>
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</tr>
<tr>
<td>$M$</td>
<td>87.57</td>
<td>65.46</td>
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<tr>
<td>Body Parts: Necessary + Additional Detail$^c$</td>
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</tr>
<tr>
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<tr>
<td>Locations of Body Parts: Necessary + Additional Detail$^d$</td>
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<td></td>
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</tr>
<tr>
<td>$M$</td>
<td>25.34</td>
<td>16.48</td>
<td>5.84</td>
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<td>2.02</td>
<td>3.04</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Note. *must be interpreted with caution because of problems with the model assumptions

$^a$Body Parts: Necessary Detail scores were obtained by dividing the total necessary descriptors from the total possible score and were reported as percentages.

$^b$Locations of Body Parts: Necessary Detail were obtained by dividing the total necessary spatial descriptions from the total possible score and were reported as percentages.

$^c$Body Parts: Necessary + Additional Detail scores were obtained by adding the total necessary descriptors needed to guide the selection of body parts to the total miscellaneous descriptors not needed, but still provided, by participants.

$^d$Locations of Body Parts: Necessary + Additional Detail scores were obtained by adding the general location descriptions (i.e., top, bottom, middle, left, right), the specific location descriptions (i.e., corner, middle, on the left/right side), and the total proximity descriptions (i.e., next to, beside, close to, on) of body parts.
First Change in Perspective-Taking Task and First Close Transfer Task

In addition to the four ANCOVAs, four independent sample t-tests were performed to compare the mean scores of participants in both testing conditions on the outcome variables in the first change in perspective-taking task. Levene’s test for homogeneity was not found to be violated among participants’ scores for the necessary detail and the necessary plus additional detail provided for Gruffee body parts. Conversely, Levene’s test was not met for the necessary detail and the necessary plus additional detail provided for locations of Gruffee parts. Of the two variables that did meet the assumption, neither of them (scores for necessary plus additional detail \[t(11) = -.59, p = .57\] and the necessary detail \[t(11) = .25, p = .81\] provided for Gruffee body parts) were found to statistically differ between testing conditions.

A subsequent analysis examined whether mean differences existed between the two testing conditions for scores on the four outcome variables in the first close transfer task. Four independent sample t-tests were performed. Levene’s test for homogeneity was not found to be violated in any of the variables. The t-tests for the necessary plus additional detail provided for furniture pieces \[t(11) = -.66, p = .52\] and for locations of furniture pieces \[t(11) = 1.27, p = .23\] did not significantly differ between conditions. Likewise, the necessary detail provided for furniture pieces \[t(11) = 1.14, p = .28\] and for locations of furniture pieces \[t(11) = .12, p = .90\] did not significantly differ between conditions, demonstrating no group differences among the four outcome variables for the first close transfer task.

Maintenance Tasks

Approximately 6.7 weeks following the second testing session, a delayed post-test
was performed to assess whether participants’ ability to consider their reader’s perspective was maintained in their written compositions over time, controlling for pre-test scores. Since significant differences were observed between the four outcome variables at the immediate post-test, four ANCOVAs were performed to determine whether these differences still existed after an extended time lag.

The distributions of scores for the four outcome variables on the delayed post-test were examined and normality assumptions were met for three out of the four variables. Scores for the necessary detail provided for Gruffee body parts were not normally distributed and demonstrated a skewness of -2.02 (SE = 0.62) and kurtosis of 3.76 (SE = 1.19). This variable still remained in the analysis for exploratory purposes.

Beery VMI-5 standard scores, PPVT-4 standard scores, Strange Stories Test scores, and ToMI scores were not significantly correlated with any of the four pre-test or delayed post-test outcome variables (p > .05). Consequently, none of these measures were added to the model as covariates.

Four separate one-way ANOVAs were performed to assess the homogeneity of variance assumption among the variables of interest. The nonsignificant result of the Levene’s test for the pre-test and delayed post-test outcome variables indicated that the homogeneity of variance assumption was not found to be violated in any of the four cases.

A test for the homogeneity of regression slopes was also conducted on the four outcome variables. The interaction between the grouping variable (testing condition) and pre-test scores for three of the four variables were found to be non-significant; however, the interaction between the grouping variable (testing condition) and the pre-test scores
for the necessary detail provided for Gruffee body parts was significant and, therefore, the assumption of homogeneity of regression slopes for this variable was violated. While this variable failed to meet two of the ANCOVA assumptions, it was still included in the analysis for exploratory purposes.

Four ANCOVAs for the delayed Gruffees post-test were performed (see Table 3). The results indicated that delayed post-test scores for all four outcome variables (i.e, the necessary and necessary plus additional detail provided for Gruffee body parts, and the necessary and necessary plus additional detail provided for locations of Gruffee body parts) were not found to significantly differ between testing conditions when controlling for participants’ pre-test scores. However, as the sample was small, it is important to examine any meaningful effect sizes. The effect sizes displayed on the delayed post-test measures for the necessary detail ($\eta^2 = .13$) and necessary plus additional detail ($\eta^2 = .28$) provided were moderate to strong, respectively, which demonstrated that some of the variance in post-test scores was accounted for by the feedback received during training trials.

A second change in perspective-taking task and a second close transfer task were administered during the third testing session. Since there were no statistically significant differences between the mean scores of experimental or control participants’ first change in perspective-taking task and first close transfer task, there was no need to compare their mean scores on both of these delayed post-test tasks to ascertain whether such skills were maintained over time.

**Distant Transfer Task**

Three independent sample $t$-tests were performed on scores from the distant
Table 3. Delayed Grufpees Post-Test: Adjusted Means and Standard Errors of the Outcome Variables for the Experimental and Control Conditions

<table>
<thead>
<tr>
<th>Outcome Variable</th>
<th>Feedback ($n = 9$)</th>
<th>Control ($n = 4$)</th>
<th>$F$ (1, 10)</th>
<th>$p$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Parts: Necessary Detail$^a$</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>$M$</td>
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<td>82.72</td>
<td>.12</td>
<td>.73$^*$</td>
<td>.01</td>
</tr>
<tr>
<td>$SE$</td>
<td>6.96</td>
<td>10.51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locations of Body Parts: Necessary Detail$^b$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>82.04</td>
<td>76.36</td>
<td>1.49</td>
<td>.25</td>
<td>.13</td>
</tr>
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<td>$SE$</td>
<td>2.53</td>
<td>3.84</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Body Parts: Necessary + Additional Detail$^c$</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$M$</td>
<td>12.84</td>
<td>12.37</td>
<td>.05</td>
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</tr>
<tr>
<td>$SE$</td>
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<td>1.71</td>
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<td>Locations of Body Parts: Necessary + Additional Detail$^d$</td>
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</tr>
<tr>
<td>$M$</td>
<td>24.32</td>
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<td>1.74</td>
<td>2.63</td>
<td></td>
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<td></td>
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</tbody>
</table>

Note. *must be interpreted with caution because of problems with the model assumptions *Body Parts: Necessary Detail scores were obtained by dividing the total necessary descriptors from the total possible score and were reported as percentages. *Locations of Body Parts: Necessary Detail were obtained by dividing the total necessary spatial descriptions from the total possible score and were reported as percentages. *Body Parts: Necessary + Additional Detail scores were obtained by adding the total necessary descriptors needed to guide the selection of body parts to the total miscellaneous descriptors not needed, but still provided, by participants. *Locations of Body Parts: Necessary + Additional Detail scores were obtained by adding the general location descriptions (i.e., top, bottom, middle, left, right), the specific location descriptions (i.e., corner, middle, on the left/right side), and the total proximity descriptions (i.e., next to, beside, close to, on) of body parts.
transfer task (i.e., the magic trick) to compare experimental and control participants on the total general descriptors provided \([t(3) = 2.32, p = .10]\), (2) the total specific descriptors provided \([t(11) = 2.66, p = .02]\), and (3) the total miscellaneous descriptors provided \([t(11) = -2.27, p = .02]\) when describing the trick. Levene’s test for homogeneity was only found to be violated among scores for the total general steps provided for the magic trick and, therefore, equal variances could not be assumed. Levene’s test was satisfied for the other two variables. Results from the independent sample \(t\)-tests demonstrated that, after an average time interval of 6.7 weeks, participants in the experimental condition \((M = 58.59, SD = 14.45)\) provided significantly more specific descriptors in their written compositions for the magic trick, relative to control participants who did not receive the training trials \((M = 31.81, SD = 21.64)\).

**Discussion**

Representing the knowledge—or lack of knowledge—of a reader has been shown to be a critical component of successful written communication. To clearly convey a message that is both comprehensible and meaningful, writers must anticipate the expectations of readers by representing their cognitive states and tailoring the communicative content accordingly. Since written discourse lacks the collaborative interaction that is present among conversational partners, a skilled writer must be able to establish common mental representations with his or her reader in the absence of an immediate and shared context (Carvalho, 2002).

Although deficits in perspective-taking have been frequently examined in AS, little attention has been paid to when student-aged populations with AS think about their reader’s knowledge state in their emergent compositions. The primary goal of the present
intervention was to ascertain whether feedback could serve as an effective method to foster perspective-taking in children and adolescents with AS in a written context. By visually and verbally highlighting the ambiguity of their written compositions, the study sought to empirically test whether consideration for the informational needs of a reader could be improved in participants and subsequently manifested in their writing.

As predicted, concrete feedback resulted in a significantly greater ability for participants to disambiguate a text and promote communicative clarity for a naïve reader in their immediate post-test instructions, after controlling for pre-test scores. Compared to matched controls, experimental participants provided the confederate with greater overall accuracy when describing Gruffee body parts to be selected for construction. Additionally, the amount of detail and overall accuracy of detail they provided for the locations of Gruffee body parts were significantly greater than controls; however, caution is warranted when interpreting these last two findings as the assumptions for both ANCOVAs were not met.

Contrary to the results from the immediate post-test, performance differences were not observed between experimental and control participants on the change in perspective-taking task and the close transfer task. The nonsignificant differences on the close transfer task suggested that, despite the immediate impact of the training trials on participants’ written compositions, improvements did not transfer to other, related tasks. While it appeared as though generalization from training trials did not occur, robust differences between testing conditions were exhibited on the distant transfer task; namely, among scores for the total specific descriptors provided. Given that this variable assessed the degree to which participants described the subtle, yet critical, components of
the magic trick in their instructions, the significant group differences in mean scores on this variable are of particular relevance in evaluating the efficacy of the intervention. In fact, the higher proportion of total specific descriptors reported in the instructions of experimental participants revealed that, not only did feedback result in short-term improvements, but that perspective-taking skills could be successfully maintained and applied to a qualitatively distinct context approximately 6.7 weeks post-intervention.

The lack of a significant difference between experimental and control participants in certain contexts, that is the change in perspective-taking task and close transfer task, raises concerns with respect to the efficacy of these measures. There are a few plausible explanations for why each task failed to elicit perspective-taking. First, the goal of the change in perspective-taking task was to evaluate whether exposure to feedback resulted in participants always providing greater detail in their instructions, rather than in the ability to represent their reader’s knowledge state. Therefore, in an attempt to overcome this problem, success on this task was contingent upon whether participants could tailor their instructions to the confederate and reduce the detail in their instructions for the four body parts that were already known to the confederate. Although experimental participants failed to provide fewer details for the pre-identified body parts, this did not conclusively demonstrate an inability to consider the perspective of another. Rather, it was incorrectly assumed that participants would inhibit the descriptiveness of their written instructions on this task when, in truth, they lacked any incentive to do so. During training trials, experimental participants were always encouraged to provide detail to reduce the ambiguity associated with their written instructions. However, since there was no penalty for being overly descriptive in the change in perspective-taking task, perhaps
participants recognized the confederate’s updated perspective but still provided more detail than necessary to ensure the correct body parts were selected.

Second, the purpose of both close transfer tasks was to assess whether any improvements from the training trials could be transferred to an unfamiliar, non-Gruffees context that required similar perspective-taking skills. However, it appeared that there might have been confounds in the design of these tasks which may have precluded participants from successfully transferring their skills to the novel contexts. For instance, both the bedroom and picnic scenes relied on the assumption that participants could describe depth and proximity in their instructions for the confederate. However, since participants received training with two-dimensional, stationary figures (i.e., Gruffees) that had body parts placed inside or around their bodies, issues with depth perception and proximity were seldom encountered. Consequently, participants were presented with the added obstacle of having to describe two complex elements in their instructions, making the task seemingly more difficult for young writers and not necessarily representative of a close transfer.

Despite the inherent limitations of both measures, it still remains unclear why experimental participants could not outperform controls on these tasks. Two contrasting hypotheses are provided: (1) the minimal exposure to training did not allow participants to properly internalize the feedback and apply gains in perspective-taking to other domains; or (2) gains in perspective-taking could be applied to other domains, but proved to be particularly challenging for young writers to employ in unfamiliar contexts. While the restricted number of training trials could possibly account for the lack of differences between testing conditions on the change in perspective-taking and close transfer tasks,
this explanation fails to address why experimental participants exhibited heightened sensitivity for their reader’s perspective in the distant transfer task, compared to controls. Therefore, the number of training trials did not seem to be the primary issue underlying the insignificant group differences.

The second hypothesis provides a more reasonable explanation; that being, keeping the informational needs of a reader in mind during writing is a cognitively taxing process, especially for young writers who are concurrently developing perspective-taking and literacy skills (Bonk, 1990). Participants in the experimental condition had to learn to be descriptive in their written compositions and tailor the communicative content of their instructions to an absent audience; however, they also had the extra cognitive load of having to apply these newly-acquired skills to unfamiliar contexts. This begs the question: how were experimental participants able to apply perspective-taking to a task that was not only unfamiliar, but that was qualitatively distinct from Gruffee-building? By having all participants actively manipulate concrete materials while dictating instructions for the magic trick, this might have provided scaffolding which reduced the cognitive complexity required for the task. The possible reduction of the information processing load for all participants might have allowed children and adolescents in the experimental condition to more easily demonstrate their newfound ability to represent reader awareness.

**Limitations**

*Issues with the sample.* Limitations were noted in terms of the sample. For instance, although parents reported that their children received a formal diagnosis of AS, this diagnostic status was not validated by a clinician. Therefore, more rigorous screening
methods would have been preferable to ensure that the results obtained from participants were, in fact, representative of children and adolescents with AS. Another issue of representativeness pertains to the heterogeneity that exists in AS. Participants presented a broad range of symptoms that underlie the syndrome; however, coupled with their comorbid disorders, it must be questioned whether the clinical profiles of these 13 individuals were characteristic of most AS children and adolescents. To minimize these concerns, future research should consider expanding the sample size to determine whether the present findings could be generalized to a larger, more diverse group of AS children and adolescents.

Expanding the sample could also increase the statistical power of the analyses performed. Though significant group differences were achieved on certain outcome measures, it would be advantageous to observe whether these results remain significant after testing more participants. Additionally, it is possible that notable trends within the results may have reached statistical significance. The moderate to strong effect sizes displayed on the delayed post-test measures for the necessary detail and necessary plus additional detail provided for the locations of Gruffee body parts suggest that significant group differences could have been achieved, had more participants been included in the study. Future research should also consider evaluating the performance of typically developing children and adolescents, which would allow comparisons to be made between neurotypical and clinical populations.

*Issues of interpretation.* The criteria used to quantify perspective-taking also had its limitations. Perspective-taking skills were scored on the basis of the frequency and accuracy of details provided by participants to describe objects and locations of objects.
Nevertheless, there is no unifying definition of what constitutes perspective-taking and, therefore, little certainty exists as to whether measures in the present study were appropriately defined and truly representative. Regardless of how perspective-taking was conceptualized and evaluated, there is still skepticism surrounding whether AS populations can convincingly consider another person’s perspective or whether this ability is achieved through alternative routes than those involved in typical development. This point is emphasized by Happé’s (1995) claim that linguistic capacity mediates success on theory of mind tasks. Accordingly, populations with AS may rely solely on language ability as a compensatory strategy for achieving theory of mind tasks, without demonstrating any consideration of or appreciation for another’s mind. In other words, it must be asked whether children and adolescents with AS improved their awareness for their reader’s knowledge state in the present study or if they simply employed other strategies to solve the tasks presented to them?

Despite the *compensatory strategy* hypothesis, participants who received training arguably exhibited consideration of their reader’s knowledge state on the distant transfer task by providing significantly more specific descriptors in their instructions than controls. Had experimental participants provided only greater general descriptors in their instructions, no conclusions could be drawn with respect to perspective-taking. However, since scores for the specific descriptors assessed the amount of detail provided that was subtle, yet critical, for the successful execution of the magic trick, experimental participants demonstrated that they could engage in perspective-taking by reporting significantly more relevant information for the confederate than controls.
Implications

Despite the limitations of the present intervention, no study to date has examined whether AS children and adolescents can learn to adapt the informativeness of their written compositions to an absent audience. For this reason, it is necessary to continue developing and evaluating the efficacy of this referential communication paradigm, as it warrants further investigation and has potential to be a valuable tool in promoting social cognition (i.e., sensitizing children and adolescents with AS to how someone may lack requisite knowledge).

Aside from the primary focus of promoting social cognition, the Gruffees paradigm has important implications for educational practices and classroom teaching. Fostering literacy is increasingly being viewed as the most important mandate during the early school years and writing is a crucial part of literacy. Being aware of whom one is writing for and what one’s audience may or may not know is central to the development of writing and revision skills, and may also contribute to children’s growth as readers. Moreover, students who can effectively address an absent reader not only recognize and apply appropriate textual cues and strategies to their writing, but they may also apply such awareness to learn from and challenge texts during reading (Wollman-Bonilla, 2001).

Since AS students pose unique challenges in classroom settings and the number of children and adolescents being diagnosed with AS is on the rise (Delano, 2007), this perspective-taking intervention could serve as a practical pedagogical tool in the early grades to address the specific academic needs of these students.
Conclusions

Collectively, the results support the hypothesis that detecting problems in one’s writing can lead to increases in perspective-taking. While few evidenced-based perspective-taking interventions are available for children and adolescents with AS, Hutchins and Prelock (2008) cite the intense time commitment and effort of traditional interventions, ranging from weeks to months, as a major reason for why such interventions are often overlooked. Moreover, of the training programs that have resulted in marked improvements, most are limited to the tasks on which training was taught and fail to generalize to other perspective-taking domains. The present study addressed the shortcomings of prior research by establishing an efficient training paradigm that not only taught participants to envision their reader’s perspective in one context, but that extended their ability to consider their reader’s perspective on an unfamiliar, naturalistic task. Furthermore, this exploratory study provided preliminary support for the immediate and sustained efficacy of a relatively short and motivating perspective-taking intervention. The significant group differences that emerged after this brief intervention and that were maintained approximately 6.7 weeks post-intervention highlight the potency of visual feedback and its usefulness in training children and adolescents with AS to adapt the informativeness of their writing to an absent audience.
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Disorders, 40, 280-289.


alternative to a theory of mind. *Autism, 6*, 343-363.


*Cognition, 13*, 103-128.


Appendix A

Gruffees Task. The Gruffees task is a computer-based paradigm that will be used for the pre-test, post-test, and training rounds of the study. In the task, children will be shown displays similar to the one presented below. Each display will have a “body” on the right hand side of the screen (with a white background) and choices of body parts on the left hand side of the screen. On the pre- and post- tests, children will be asked to copy a standardized Gruffee (i.e., a Gruffee that is pre-made by the experimenter) using the body parts on the display. On training rounds, children will be allowed to build their own Gruffees with the restriction that only eight body parts may be used.

Appendix B

Change in Perspective-Taking Task. In the change in perspective-taking task, children will be told that a confederate is familiar with four of the body parts that will be selected to build a Gruffee, but unaware of how any of the parts will be arranged. The four parts that are familiar to the confederate will be highlighted on the children’s screen. After the children have built their Gruffee and dictated
instructions on how to recreate the image, researchers will evaluate whether children took their reader’s knowledge into account. More specifically, if children are cognizant of their reader’s awareness, they should describe pre-selected items with *less* detail in their instructions, since their reader already knows these items will be used to create the Gruffee.

Appendix C

*Close Transfer Task (Bedroom Scene).* To assess whether perspective-taking skills can be transferred from the Gruffees intervention to an unfamiliar task, children will be presented with an empty bedroom scene and an assortment of furniture that varies in colour, shape, and/or size. Children will be asked to construct a bedroom using eight of the furniture pieces provided and to dictate step-by-step instructions for a confederate to recreate the image.

Appendix D
Close Transfer Task (Picnic Scene). To assess whether perspective-taking skills can be maintained from the Gruffees intervention and transferred to an unfamiliar task, children will be presented with an empty picnic scene and an assortment of related items that vary in colour, shape, and/or size. Children will be asked to construct a picnic scene using eight of the items provided and to dictate step-by-step instructions for a confederate to recreate the image.

Appendix E

Script for the Magic Trick

1. First, before you bring your audience in, take a small white pompom and hide it inside the blue cup.

2. Next, stack the cups so that the blue cup is in the middle. Make sure the cups are facing up like this. Now you can bring your audience in to see the magic trick.

3. Begin by flipping the cups down on to the table. Make sure to flip the cups quickly so that the secret pompom does not fall out of the blue cup. See, if you flip the cup too slowly, your audience will see the pompom that is hidden inside.

4. Next, take a pom pom from the pile. Make sure to take a pompom that is exactly the same as the one that is hidden under the blue cup. Place the pompom on top of the blue cup and say “I’m going to make this pompom magically go through the blue cup. Watch!”

5. Now, take the two cups on the side and stack them on top of the blue cup. Make sure the blue cup is on the bottom.

6. Wave your hands around, so it looks like you’re doing magic.

7. Give the stack of cups a good tap so that it looks like the pompom is falling through the cup.

8. Now lift all the cups together and reveal the pompom that appears to have magically fallen through.
Appendix F

Revised Version of the Strange Stories Test (O’Hare, Bremner, Nash, Happé, Pettigrew, 2009). The Strange Stories Test consists of a set of vignettes about everyday situations in which people say things they do not literally mean. For instance, children must accurately identify the underlying intention behind a character’s statement that was not literally true. Scores from each story are rated on a 0–2 scale as incorrect, partially correct, or fully correct. Above is an example of one of the stories.

Appendix G

Definitely Not | Probably Not | Don’t Know | Probably | Definitely

1. My child understands that when someone says they are afraid of the dark, they will not want to go into a dark room.
2. My child understands that to know what is in an unmarked box, you have to see or hear about what is in that box.
3. My child understands that when people get what they want, they will be happy.
4. My child can pretend that one object is a different object (for example, pretending a banana is a telephone).
5. My child understands that, when I show fear, the situation is unsafe or dangerous.

Theory of Mind Inventory (ToMI; Hutchins, Prelock, & Bonazinga, 2010). The ToMI is designed to measure children’s theory of mind competence as determined by their parents or primary caregivers. Items cover a range of topics pertaining to the thoughts and feelings of children in real-life social situations. Respondents are instructed to read each statement and indicate the degree to which their child would engage in a particular social response on a continuous scale from “definitely not” to “definitely”. Sample items from the ToMI are included above.
Appendix H

How to Score Gruffee Instructions

- **Body Description**: Each Gruffee should be comprised of 8 body parts (i.e., 8 items). Score the child’s description for each item separately (even if the child does not have 8 separate instructions).
  
  a. **Body Part**: Write the name of the body part that is being described (i.e., Arm, Eye, Hair, Horn, Leg, Mouth)

  b. **Total Possible Score**: This is the total score the child could receive if they described all the necessary features of a given body part. Calculate for each item and then tally all the scores to determine a grand total at the bottom of the page.
    
    i. On pre- test, post-test, and perspective taking trials, these columns have been filled out for you
    
    ii. On Training and Transfer trials you will need to fill this out. Use the attached Answer key to determine what the score should be for each item. In general:
      - if the item has 4 variants: total possible score is 2
      - if the item has 2 variants: total possible score is 1

- **Child Description**: This is the score for the child’s actual description of each item/body part. Score each item individually and then tally all the scores at the bottom.

  a. **Necessary Descriptors**: These are features that the child MUST give in order to uniquely identify the intended body part. The necessary descriptors for each item on the displays are provided in the attached answer key. Write down the child’s actual description on the left hand side of the sheet (e.g., “blue”) and give the child a score of 1 for each necessary descriptor that they give. NOTE:
    
    i. **For items that have 4 variants on the display**: The child MUST provide 2 features (e.g., Color AND Shape). Children can therefore only receive a maximum score of 2 for each item.
    
    ii. **For items that have 2 variants on the display**: The child MUST only provide 1 feature (e.g., Color OR Shape). Children can therefore only receive a maximum score of 1 for each item.

  b. **Miscellaneous Descriptors**: These are additional features that the child may describe that are not necessary for identifying the intended item. Write down each of the child’s misc. descriptions in the left hand column and give a score of 1 for each.

    NOTE:

    i. **For items that have 2 variants on the display**: Each of these items can be described by one of two possible features (e.g. Shape OR Size). If the child provides both these features then score one feature as “Necessary” and one as “Miscellaneous”
• **Location Description:** This section is to score the child’s spatial description of where the different items should be placed. Again, score for each item individually and tally at the bottom at the page.

  a. **Accuracy:** This is a general gauge of how accurate the child’s spatial description is. *Fill this out after* you have completed the other 3 sections. Score the child accordingly:

     i. **Give a score of 0:** If the child provides no spatial description for a given item

     ii. **Give a score of 1:** If the child provides a spatial description but it is vague or could be misinterpreted for another location.

     iii. **Give a score of 2:** If the child has provided a description that effectively describes where the item should be placed (i.e., by reading their description you could accurately place the given item)

  b. **General Location:** This refers to the 5 general points on the Gruffee that were mentioned during practice: (a) top, (b) bottom, (c) middle, (d) left/green side, (e) right/red side. Write down the child’s actual description in the left hand column and give a score of 1 if this is provided. Children should only receive a max. score of one for each item in this column.

  c. **Specific Location:** This is for any additional spatial description that a child may give (e.g., top middle; bottom on the left side). Again, write down the child’s description and give a score of 1 for each additional description.

  d. **Proximity:** This is to score any descriptions that refer to an items relation to other objects on the display (e.g., next to the blue arm, on top of the carpet, etc.) Write down the actual description and give a score of 1 for each.

**Additional Notes**

• **Multiple items:** Children can use multiples of the same item when building their gruffees/scenes (e.g., two brown eyes).

  o **For the body description:** Score both items the same ONLY if the child makes it clear that they are using two of the same item (e.g., take two brown eyes and put them...). If the child, however, is vague about the second item (e.g., Not put another arm) then score it separately.

  o **For Location Description:** Score each item as if it is a separate item. If the child describes the location for both items in the same instruction (e.g., put both eyes on the bottom), then score as if the spatial description (“on the bottom”) were provided for each item.

• **Descriptions referring to the direction an item is facing:** Orientation was not manipulated on any of the powerpoint displays so code these types of descriptions (e.g., facing up, facing the red side) as miscellaneous.
**Coding Location:**

- **If the child wants to describe an item in the center of the body:** In addition to saying “middle” or “center”, the child must specify “of the body” or “of the Gruffee” in order to get full accuracy marks. If they simply say “center” or “middle” (even if they specify “right in” or “very”) then give them an accuracy score of 1.
  - Enter “of the body” or “of the Gruffee” in the proximity column
  - “of the body” ≠ “on the body”: If the child just says “on the body”, don’t code as proximity
  - Enter “right in” or “very” in the specific column
  - Code “inside” as “middle” (e.g., “put the eye on the inside of the Gruffee”)

- **If the child says “the other” (e.g., “the other corner”):** Code “other” as a specific location

- **If the child says “on the black line”:** Code as a proximity description

- **If the child says “almost” (e.g., “almost on the bottom”):** Code “almost” as a proximity description. “Almost” = “near”

- **Proximity descriptions that refer to a poorly described item:** If the proximity description refers to another item that had not been clearly described (e.g. “put on top of blanket” when it was not initially clear where the blanket was placed) then both items must receive an accuracy score of 1 unless the child provides additional information about the current item’s location.

- **If the child mixes up left and right:** Give the child an accuracy of 1. In this case, the child has given a spatial description, just not an accurate one.

- **Coding Location on Close Transfer Tasks:** Because it is less likely that children will use descriptions such as “top, bottom, middle, left, right” to refer to the whole scene (e.g. “place on the top of the picture”), code any references to the borders (e.g., blue side, green side) and background (e.g., blue wall, orange wall, grass, sky) as general location descriptors. Save proximity descriptions for descriptions between moveable items and/or when proximity phrases are used (e.g., “near the...”, “close to...”, “beside the...”, “between the...”).
  - **Bedroom scene:** All walls (blue, orange, white) and the floor count as general descriptors. If the child says something like “put it on the corner of the blue and white wall”, then enter one wall in the general location column (e.g., blue) and enter the other wall (i.e., white) in the specific location column. Enter “corner” in the specific location column as well. Similarly, if a child says “put it on the top of the blue wall” then enter “blue wall” under general and “top” under specific.
    - **If the child doesn’t specify which “wall”**: (e.g., “put in on the wall”) Code “wall” as a general location.
• **Picnic Scene**: All references to the colored borders (blue, red, yellow, green), the sky, and the grass, can be coded as general location. Therefore, if a child says “put it in the middle of the grass”, enter “grass” in general location and “middle” in specific location.

  o **Coding Magic Trick**: If the child mixes up the order of the steps, write down the child’s order on the side of the coding sheet.

### Distant Transfer

This task is different from the others in that there is no visual display to compare the child’s response to. The following are the steps to the magic trick and the “necessary” descriptions that the child should include at each step:

<table>
<thead>
<tr>
<th>Step</th>
<th>Necessary Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Hide pom pom</td>
</tr>
<tr>
<td></td>
<td>• Make sure to do this before your audience is there</td>
</tr>
<tr>
<td></td>
<td>• Make sure the pom pom is small and white</td>
</tr>
<tr>
<td>2.</td>
<td>Stack the cups</td>
</tr>
<tr>
<td></td>
<td>• Make sure the cup with the pom pom is in the middle</td>
</tr>
<tr>
<td></td>
<td>• Make sure the cups are stacked facing up</td>
</tr>
<tr>
<td>3.</td>
<td>Flip the cups</td>
</tr>
<tr>
<td></td>
<td>• Flip the cups quickly so that the secret pom pom does not fall out</td>
</tr>
<tr>
<td>4.</td>
<td>Place another pom pom on top of the cup</td>
</tr>
<tr>
<td></td>
<td>• Pom pom must be the same as the hidden pom pom</td>
</tr>
<tr>
<td></td>
<td>• Pom pom must be on top of the middle cup</td>
</tr>
<tr>
<td>5.</td>
<td>Stack the cups</td>
</tr>
<tr>
<td></td>
<td>• Make sure the cup with the pom pom is on the bottom</td>
</tr>
<tr>
<td>6.</td>
<td>Wave arms around</td>
</tr>
<tr>
<td></td>
<td>• This is so it looks like your doing magic</td>
</tr>
<tr>
<td>7.</td>
<td>Tap the cup</td>
</tr>
<tr>
<td></td>
<td>• So that it looks like the pom pom is falling through</td>
</tr>
<tr>
<td>8.</td>
<td>Lift and reveal</td>
</tr>
<tr>
<td></td>
<td>• Pick up all 3 cups together</td>
</tr>
</tbody>
</table>

Score accordingly:

* **Steps**: Give a score of 1 for each step the child includes

* **Necessary Instructions**: Give the child a score of 1 for each necessary instruction that the child includes

* **Additional Instructions**: Give the child a score of 1 for each additional instructions that is included for each step (e.g., say “Voila!”)

Tally all the scores.